

REMARKS

Independent Claims 1, 28, 33, and 44 have been amended by applicants on their own initiative, to clarify the meaning of the claims, so that the claims precisely reflect the subject matter disclosed in the application Specification. The amendments are not based on any of the grounds for rejection of the claims and do not affect the patentability of the claimed subject matter.

Claim Rejections Under 35 USC § 103

Claims 1 - 57 are rejected under 35 USC § 103(a) as being unpatentable over U.S. Patent No. 6,323,132, to Hwang et al., in view of U.S. Patent No. 6,094,334, to Bedi et al.

The present Hwang et al. application pertains to a method of pre-heating and then etching the surface of a semiconductor substrate where the surface is a metal-containing layer. The example metal-containing layers contain platinum, ruthenium, or iridium, which all require relatively high temperature etch processing conditions. The pre-heating is carried out using a plasma which is sufficiently reactive with the metal-containing layer that deposits or residues which include the metal and which are formed during the preheating are more easily etched than the metal itself. This enables easier removal of the deposits or residues which are inadvertently sputtered onto adjacent surfaces during the ion bombardment which occurs during plasma heating. The deposits or residues are removed during subsequent etching of the metal-containing layer. The '132 patent to Hwang et al. relates to a method of etching a platinum electrode layer, and the minimum etch temperature is the same as that specified in the present application. However, the substrate temperature is raised [←] using heat exchange between the substrate and the underlying support pedestal. There is no mention of plasma heating. There is no mention or even suggestion about using a lightly reactive plasma to do the substrate heating.

Although Bedi et al. discloses the general concept of plasma preheating of a substrate prior to an etch process, Bedi et al. actually teaches away from plasma heating, alleging that highly energetic plasma species impacting the substrate affect etching characteristics of the substrate. Bedi

recommends, instead, the use an electric substrate heater to heat the substrate. More importantly, Bedi et al. does not disclose any particular gases for use in plasma substrate preheating and makes no mention of using a plasma source gas which will enable easier removal of deposits or residues formed during the substrate heating process.

In particular, the '132 patent to Hwang et al. discloses a method of etching a platinum electrode layer disposed on a substrate to produce a semiconductor device including a plurality of platinum electrodes. (Abstract) According to the '132 patent disclosure, prior to etching the platinum electrode layer, the substrate must be heated to a temperature greater than about 150°C. Referring to Col. 21, line 66, through Col. 22, line 8, of Hwang et al.: "... before the platinum electrode layer 16 is etched, the semiconductor substrate 12 supporting the platinum electrode layer 16 is heated to a temperature greater than about 150°C... The semiconductor substrate 12 is heated by the pedestal which supports the wafer 10 during the platinum etching process." The '132 patent to Hwang et al. says nothing about heating the substrate by exposing the substrate to a preheating plasma, as claimed by applicants.

Bedi et al. discloses an electrostatic chuck for holding a substrate in a process chamber comprising an electrostatic member comprising a polymer covering an electrode, the polymer having a receiving surface for receiving the substrate. A heater abutting the polymer is provided to heat the substrate during processing of the substrate. The heater has a resistance that is sufficiently low to heat the substrate without causing excessive thermal degradation of the polymer. (Abstract)

Bedi et al. is cited by the Examiner as teaching heating of a substrate using a preheating plasma. The Examiner specifically refers to Col. 5, lines 6 - 13 and 23 - 25, of Bedi et al. Col. 5, lines 6 - 23, reads as follows: "In addition, the resistive heating element 145 comprises a resistance that is sufficiently high to raise the temperature of the substrate 25 by at least about 150°C to facilitate the etching of high conductivity metals, such as for example, platinum or copper. Generally, a plasma heats up a substrate 25 because of the energetic impingement of charged and neutral plasma species onto the surface of the substrate 25. While the energy of the plasma can be

increased to increase the temperature of the substrate 25, it is not always desirable to do this, because highly energetic plasma species often provide different etching characteristics than low energy plasma species. Thus, it is preferred to change the temperature of the substrate using a heater 130, and because the substrate 25 is already partially heated by the plasma, the resistance of the resistive heating element 145 of the heater 130 can be selected to increase the temperature of the substrate 25 by a smaller amount than the ultimate temperature needed for the process." Thus, although the Bedi et al. reference discloses the general concept of plasma preheating of a substrate, Bedi et al. discourages the use of plasma preheating due to its effect on the etch characteristics of the metal impacted during the plasma heating. Further, Bedi et al. does not disclose any particular gases for use in plasma substrate preheating, and there is no mention of using a low reactivity plasma during substrate preheating.

In summary, Hwang et al. does not teach plasma preheating of a substrate; Bedi et al. mentions the general concept of plasma preheating, but essentially teaches against it. Neither Hwang et al. nor Bedi et al. teach preheating of a substrate using a plasma which is reactive with a metal-containing layer that is subsequently to be etched, as claimed by applicants in Claim 1. Referring to page 7, lines 15 - 24, of applicants' originally filed Specification: "Ion bombardment heating of a substrate which leads to sputtering/etching of an exposed layer which is to be etched is possible without affecting the critical dimension of the etched feature if the plasma source gas used for heating enables the subsequent removal of substantially all of the sputtered/etched material generated during the preheating step. The sputtered/etched residue from preheating is removed during the etch step which follows the preheating of a substrate, for example. To enable removal of a preheating sputtered/etched material residue, the plasma source gas used to generate the preheating plasma may provide a plasma which is slightly reactive with at least the exposed layer to be subsequently etched." "This inventive method provides a relatively quick way of heating a substrate without using a resistance heater in an electrostatic chuck, thereby avoiding the added cost of such equipment and the undesired effects when needing to cool the substrate. Further, this inventive method is not

focused on eliminating the sputtering of material during a substrate preheating step, but rather is focused on removing the material that is sputtered during the preheating step during the pattern etching step." (Specification Page 8, lines 21 - 26.)

Neither Hwang et al. nor Bedi et al. teach particular combinations of plasma preheating gases and metal-containing layers, as claimed by applicants in Claims 2 - 57.

Whether taken alone or in combination, neither Hwang et al. nor Bedi et al. teaches or even suggests applicants' claimed invention. In light of the above distinctions, applicants respectfully request withdrawal of the rejection of Claims 1 - 57 under 35 USC § 103(a) over Hwang et al., in view of Bedi et al.

Double Patenting Rejection

Claims 1 - 3, 28, and 33 are provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over Claims 1 - 3, 13, 15, and 25 of copending Application Serial No. 09/747,652, of Hwang et al.

Applicants do not agree that there is double patenting, since the scope of the claims is considered by applicants to differ significantly. Despite the disagreement, in the interest of obtaining an early allowance and issuance of the present application, applicants are submitting a Terminal Disclaimer under 37 CFR § 1.321(c), so that patent enforcement availability will not be lost for the time period necessary to argue the double patenting issue.

In light of the filing of the Terminal Disclaimer, applicants respectfully request withdrawal of the rejection of Claims 1 - 3, 28, and 33 under the judicially created doctrine of obviousness-type double patenting, over Claims 1 - 3, 13, 15, and 25 of copending Application Serial No. 09/747,652.


Applicants believe that all presently pending claims are in condition for allowance, and the Examiner is respectfully requested to enter the present amendments and to pass the application to allowance.

U.S. Express Mail No.: EU721509950US

Attorney Docket No.: AM-5256-2

SPE Utech has indicated that he would prefer that applicants conduct an Examiner interview prior to Final Rejection. If the Examiner does not find the claims to be allowable in view of the distinctions provided above, the Examiner is requested to please contact applicants' attorney so any issues may be discussed prior to a final rejection.

Respectfully Submitted,



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U.S. Express M. No.: EU721509950US
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AMENDMENT "A"
VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

1. (Once Amended) A method of preheating a substrate which includes a metal-containing layer on an exposed surface of said substrate to a temperature of at least 150 °C, wherein said method comprises exposing said exposed surface of said substrate to a preheating plasma which is sufficiently reactive with said metal-containing layer that a deposit or residue formed during preheating which includes metal from said metal-containing layer is more easily etched than said metal-containing layer during a subsequent plasma etching of said metal-containing layer, wherein said metal is selected from the group consisting of platinum, iridium, ruthenium, and combinations thereof.

28. (Once Amended) A method of plasma heating a substrate and etching a platinum-containing layer [included in] on an exposed surface of said substrate, said method comprising:
 - a) supplying a first nitrogen-comprising plasma source gas to a process chamber containing said substrate;.
 - b) preheating said substrate to a temperature of at least 150 °C using ion bombardment from a plasma generated from said first nitrogen-comprising plasma source gas;
 - c) supplying a second nitrogen-comprising plasma source gas to said process chamber; and
 - d) forming a plasma from said second nitrogen-comprising source gas to etch said platinum-containing layer while removing platinum-comprising deposits generated during said preheating of said substrate.

U.S. Express M No.: EU721509950US
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33. (Once Amended) A method of plasma heating a substrate and etching a ruthenium-containing layer [included in] on an exposed surface of said substrate, said method comprising:

a) supplying a first plasma source gas comprising a gas selected from the group consisting of nitrogen, oxygen, or combinations thereof into a process chamber containing said substrate;.

b) preheating said substrate to a temperature of at least 150 °C using ion bombardment from a plasma generated from said first plasma source gas;

c) supplying a second plasma source gas comprising oxygen to said process chamber;
and

d) forming a plasma from said second source gas to etch said ruthenium-containing layer while removing ruthenium-comprising deposits generated during said preheating of said substrate.

44. A method of plasma heating a substrate and etching an iridium-containing layer [included in] on an exposed surface of said substrate, said method comprising:

a) supplying a first plasma source gas comprising a gas selected from the group consisting of nitrogen, oxygen, and combinations thereof into a process chamber containing said substrate;.

b) preheating said substrate to a temperature of at least 150 °C using ion bombardment from a plasma generated from said first plasma source gas;

c) supplying a second plasma source gas to said process chamber; and

d) forming a plasma from said second source gas to etch said iridium-containing layer while removing iridium-comprising deposits generated during said preheating of said substrate.[.]